# SNCF and its partners foresee autonomous trains by 2023

PARIS, 12 SEPTEMBER 2018

**SNCF, the Institut de Recherche Technologique (IRT) Railenium, Alstom, Altran, Ansaldo, Apsys, Bombardier, Bosch, Spirops, and Thales announce the creation of two consortiums to develop two autonomous train prototypes within five years.**

## A revolution in rail transport

With this disruptive project, the French Public Railway Group is launching construction of the future rail system. Within five years, SNCF will become the first railway to operate autonomous trains for both freight and passenger transport. SNCF and its partners are thus positioning France at the cutting edge of innovation in the sector.

Two consortiums made up of technology and industrial companies were created last January and will be led by SNCF and IRT Railenium for a period of five years.

- One consortium, whose members are Alstom, Altran, Ansaldo, and Apsys, will design and build a prototype of an autonomous freight train.
- The second consortium, whose members are Bombardier, Bosch, Spirops and Thales, will produce a prototype of an autonomous TER commuter train.

The total budget for this phase of the project is €57 million. SNCF will provide 30% of the funding, the State, 30%, and the partners, 40%.

## Open innovation: uniting diverse expertise

The partnership agreements bring together major manufacturers in the rail, automotive, aeronautics, and intelligent systems sectors as well as companies working in the fields of engineering and artificial intelligence. They will receive strong support from the public sector via the French National Research Agency (ANR).

The French Rail Safety Institute (EPSF) and the French Information Systems Security Agency (ANSSI) will work with both these consortiums to ensure that rail safety and cybersecurity are fully integrated from the start of the projects.

This wide range of expertise will enable progress in all areas key to the development of the future autonomous train – obstacle detection, signal reading, geolocation, environmental and train surveillance, and unforeseen events management.

"These human and technological issues are crucial. We are mustering the collective intelligence, experience, capabilities, and know-how of partners in diverse industrial sectors", explains Luc Laroche, Director of the Autonomous Train project, adding: "These partnerships are unprecedented anywhere in terms of the goals, the approach, and the assembled competencies".

## Benefits for passenger and freight transport

Train automation will translate into tangible benefits for passengers and freight shippers:
+ Increased capacity: operating more trains means the ability to transport more people and goods (see video);
+ Greater fluidity and regularity thanks to traffic coordination and optimised speeds, making it easier to deal with unforeseen events (see video);
+ Ecological gains thanks to decreased energy consumption (see video).

"The digital transformation of the network and signalling will allow more trains and better trains to operate. And it is essential to the development of autonomous trains. It will make us a champion of digital in industry", says Patrick Jeantet, President of SNCF Réseau.

"Transport more people and more goods, with better service, lower energy consumption, and even greater safety – all will become possible with autonomous trains. With autonomous trains, all traffic will be coordinated and rail operations will be more fluid. In addition to greater fluidity, train services will be more regular and more punctual. This is a major issue for SNCF, which operates 17,000 trains and transports 4 million passengers each day", says Guillaume Pepy, Chairman of SNCF. "We are fully engaged with our partners in designing the train of the future… and the future of trains."

The objective of the Autonomous Train project is to have semi-autonomous trains on the tracks by 2020 and fully automated trains running by 2023.

## About the SNCF Group

SNCF is a global leader in passenger and freight transport services, with revenue of €33.5 billion in 2017, of which one-third on international markets. With its foundations as the French railway and its expertise as an architect of transport services, SNCF employs 270,000 people in 120 countries. Its aim is to become the benchmark for mobility and logistics solutions in France and worldwide. SNCF has six core businesses: SNCF Réseau (management and operation of the French rail network); commuter transport (mass transit in the Paris region, TER regional rail, and Keolis in France and worldwide); long-distance rail (TGV inOui, Ouigo, Intercités, Eurostar, Thalys, Ouibus, and others along with ticket sales through Oui.sncf); SNCF Gares & Connexions (station management and development), SNCF Logistics (worldwide freight transport and logistics with Geodis, Fret SNCF, and Ermewa), and SNCF Immobilier (management and development of SNCF property and land assets).

+ Find out more, **sncf.com**

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## The partners

### Alstom

**Jean-Baptiste Eyméoud, CEO, Alstom France**
«This joint project with SNCF, IRT Railenium, and the other consortium partners is a major opportunity for Alstom to capitalise on its competencies and its innovations in the field of railway automation and autonomous transport and thus develop leadership in new autonomous and digital mobilities.»

### Altran

**William Rozé, COO, Altran Europe**
«Since we are involved in connected, autonomous, and intelligent mobility in the automotive and aerospace sectors, we are proud to be one of the architects of the transformation of the railway industry in the coming years by working on the technological challenges of tomorrow's mobility.»

### Ansaldo

**Gilles Pascault, CEO, Ansaldo France**
«Ansaldo STS, a longtime partner of SNCF in the field of advanced signalling and control-command technologies, offers a new approach to transport solutions. The autonomous train project is a new opportunity to innovate with SNCF and to further develop existing technologies to make the railway industry even more modern and efficient.»

### Apsys

**Christian Forestier, CEO, Apsys**
«We are proud to partner with SNCF in this Autonomous Train automation project. It is a another opportunity for APSYS to work in the field of cybersecurity in the production of actual transport prototypes.»

### Bombardier Transportation

**Laurent Bouyer, President, Bombardier Transportation France**
«The Bombardier Transportation engineers in Hauts-de-France are ready to take on this challenge with SNCF and the consortium partners. Their task will be to integrate the technological building blocks to automate a Regio 2N and make it the first French autonomous passenger train. This is a strategic project for Bombardier and for the railway industry.»

### Bosch

**Heiko Carrie, President, Bosch France Benelux**
«A leading supplier of mobility solutions, the Bosch Group is pleased to be part of this consortium and to be able to contribute with its technology to this next important step in the development of the autonomous train.»

## Railenium

**Yves Ramette, President, IRT Railenium**
«The Autonomous Train» is a core project in the research and innovation strategy of Railenium, the technological research institute for the French railway sector. We are pleased to bring together in this framework leading industrial and academic partners to carry out this collaborative project whose aim to address the technological and scientific challenges of the future rail system.»

## SpirOps

**Jérôme Hoiban, Co-founder, SpirOps**
«A pioneer in research and development in the field of Artificial Intelligence for over 14 years, SpirOps has developed proprietary technologies for modelling human behaviour. Crowd simulations and autonomous vehicles are subjects we deal with every day. We believe the application in rail transport of these two types of complementary expertise is relevant to the technical challenge of operating totally autonomous trains.»

## Thales

**Patrice Caine, chairman and CEO, Thales**
«A pioneer in automated metro systems for more than 30 years and an expert in railway signalling, Thales is capitalising on its command of critical digital technologies – connectivity, big data, artificial intelligence, and cybersecurity – which are applied in rail transport, aeronautics, aerospace, defence, and security, to develop with SNCF the autonomous train.»

## Our expertise

Altran is a global leader in innovative engineering projects involving complex, high-value-added systems in the aerospace, automotive, energy, and other sectors. Working with its clients as a technological and industrial partner, Altran wishes to make a strategic co-investment in the railway ecosystem, as it has done in other sectors by providing long-term support to companies (e.g. SNCF, ALSTOM) in transformation projects. The consortium will benefit from Altran's know-how in methods, tools, and technologies, the cross-fertilisation of its research projects, its industrial applications, and its World Class Centres in numerous sectors such as the automotive industry and fields like autonomy technologies, artificial intelligence, deep learning, Internet of Things, and data fusion.

## Our contribution to the consortium

Altran will assist SNCF in the management of a complex systems project with its Model Based System Engineering. Drawing on its experience in the design and validation of autonomous systems, particularly in the automotive field, Altran will provide the overall integration and validation strategy for the autonomous Convoi Fret (freight train) system. This will allow a large number of combinatorial tests to be validated using methods, tools, modelling, and massive calculation simulations. Altran's tasks will also include the technology for perceiving the environment outside the train using sensors (image, sound, vibration, etc.) and self-learning algorithms (IA, deep learning, and data fusion).

## Our ambition

Altran is proud to participate in the radical transformation of the railway industry for the coming decades by helping the major players to address new technological challenges and thus enable them to offer safer and more efficient mobility solutions in the future. In the years ahead, Altran will be a key partner in designing, developing, validating, and operating future autonomous rail systems.

## About Altran

Altran ranks as the undisputed global leader in Engineering and R&D services (ER&D), following its acquisition of Aricent. The company offers clients an unmatched value proposition to address their transformation and innovation needs. Altran works alongside its clients, from initial concept through industrialization, to invent the products and services of tomorrow. Combined, Altran and Aricent generated revenues of €2.9 billion in 2017, with some 45,000 employees in more than 30 countries.

ALSTOM

## Our expertise

Alstom has the largest centre of excellence for railway signalling and electronics in France, employing over 1,500 professionals in the fields of engineering, industrial systems, and project management. At the cutting edge of railway automation for over 30 years, Alstom is a supplier of all on-board and ground-based electronic sub-systems from the lowest to the highest safety levels for both rolling stock and signalling applications. In the field of safety automation, Alstom is a recognised global leader capable of meeting the full range of rail system requirements for metros and passenger and freight trains. An internal R&D programme called «Driving Automation» whose aim is to make all solutions in the product portfolio autonomous has been underway for several years.

## Our contribution to the consortium

As the leader of the «ATO Convoi Fret» (freigh train) consortium, Alstom is working with its partners to automate the operation of freight trains up to level GoA4, with fully automated operation of the locomotive with both ERTMS and conventional lineside signalling. Alstom brings many competencies and a proven track record to the project. In the metro market, Alstom has supplied many GoA4 fully automatic metros in cities like Singapore and Lausanne all over the world. At present, Alstom is building about 83 CBTC lines totaling more than 1,500 km, of which more that 43 are operated with varying degrees of autonomy. In mainline trains, Alstom is very strongly positioned, particularly for ERTMS signalling, as the company is the leading supplier of critical on-board calculators. Alstom is also at the head of the European working group TD2.2 Shift2Rail, which is drawing up the specifications and modelling the ATO technical solution that will serve as the basis for the standardisation of the automated operation of mainline trains across all of Europe in the future.

## Why we are joining this project

This partnership is another opportunity for Alstom to confirm that autonomy is a strategic priority in the development of all the mobility solutions in its portfolio, both in the railway sector (passengers and freight) and in related transport sectors like buses and shuttles. Alstom sees this project bringing together all its current objectives and initiatives and serving as a catalyst that will greatly increase its capacity for innovation in autonomous operation.

## About Alstom

As a promoter of sustainable mobility, Alstom develops and markets systems, equipment and services for the transport sector. It offers a complete range of solutions (from high-speed trains to metros, tramways and e-buses), passenger solutions, customised services (maintenance, modernisation), infrastructure, signalling and digital mobility solutions.

Alstom is a world leader in integrated transport systems. In 2017/18, the company had sales of €8.0 billion and booked orders worth €7.2 billion. Headquartered in France, Alstom is present in more than 60 countries and employs 34,500 people today. The know-how of its some 8,650 employees in France benefits both French and international customers. Its activities create 25,000 jobs in France at its 4,500 French suppliers.
www.alstom.com

Ansaldo STS A Hitachi Group Company

## Our expertise

Among Ansaldo STS's autonomous transport projects, the fully automatic Copenhague metro, in service since 2002, is certainly the best known. Since then, Ansaldo STS has further developed technologies that were already advanced at that period to meet the needs and requirements of its clients, reaching a new stage of innovation in rail transport by putting into operation the first fully autonomous freight train in the world on a line 280 km long. These technological accomplishments in passenger and freight transport are, above all, the outcome of true partnerships with our clients in which we innovate together and apply technological advances that contribute to continual improvements in safety and the density of rail and urban traffic all over the world.

## Our contribution to consortium

As an innovative company and member of the consortium that is developing the autonomous freight train, Ansaldo STS's contribution is to demonstrate project feasibility by providing solutions and combinations of technologies that will deal with the challenges and changes that will come with the rollout and commercial operation of autonomous trains. Ansaldo STS is particularly involved in the specification and general architecture phases for the system and in the development of the core of the automatic control system. It is also bringing its expertise in the secure geolocation of trains.

## Our ambition

Technological innovation is embedded in the DNA of the Ansaldo STS Group, whether one is speaking of the first Parisian metros, the first high-speed train lines in France, Europe, and Asia, or more recently, the first autonomous transport systems and our contribution to the implementation of advanced technologies that have become today's standards (ERTMS, CBTC, and others).
This autonomous train project undertaken for SNCF is a new opportunity to innovate together and further develop existing technologies to make the railway industry even more modern and better performing.

## About Ansaldo STS

Ansaldo STS is an international technology company that designs, supplies, and manages transport and signalling systems for railways and metros. It acts as a lead contractor and systems integrator for turnkey projects worldwide. Ansaldo STS, a company in the Hitachi Group since 2015, is headquartered in Genoa, Italy, and employs 4,228 people in 30 countries. In 2017, it had revenues of €1,361 million, with a gross operating margin (EBIT) of €100.8 million and consolidated net profit of €64.9 million. www.ansaldo-sts.com

apsys
SECURING YOUR BUSINESS

## Our expertise

APSYS, a subsidiary of Airbus, assists the Group's divisions in defining and implementing their safety/security product strategy for E2E engineering processes.

This know-how is particularly advanced in the air transport sector, where, in 2017, and despite the very sharp increase in traffic, there were no fatal commercial aviation accidents for the first time ever.

APSYS is now putting its know-how to work in other transport sectors (rail in particular, in association with Alstom), and more specifically, in the development of autonomous transport systems, where automatic control architectures are by definition more vulnerable to dysfunctions and cyber threats.

As a result, APSYS is an obvious partner for the autonomous train project, and it is pleased to bring its proven expertise in air transport to this effort.

## Our contribution to the consortium

In the project to develop an autonomous freight train prototype, APSYS will supply the cybersecurity solutions and ensure that this aspect is taken into account in all phases of the project. Cybersecurity will have to be factored into the technical design with a view to industrialisation later on. APSYS is involved in the various phases of the product life cycle: definition of security needs, definition of technical specifications and the security architecture, and development and application of the risk analysis across the full life cycle.

# BOMBARDIER

## Our expertise

With a focus on automation for over 40 years, Bombardier is the market leader in driverless shuttles and has gained vast experience all over the world in the field of automation. More and more on-board «intelligent» technologies equip our trains, our driverless shuttles and metros have transported more than 3 billion people in many cities across the globe, including Singapore, Beijing, Munich, and New York, and we have automated existing systems such as the Madrid metro.
Bombardier's engineers have developed many intelligent technologies that are key components of the autonomous train such as signalling systems, energy-saving driving assistance equipment, driving assistance systems, automatic doors, obstacle detection systems for tramways, and remote-controlled freight trains.

## Our contribution to the consortium

Bombardier Transportation will reinvent the architecture of an existing conventional train, the Regio 2N, to integrate the array of new technologies essential to the autonomous train and supply the interface between the train and the rail infrastructure. Bombardier's Crespin site in northern France will provide human and technical resources as well as equipment.

First will come an analysis of the impact that the functions of an autonomous train will have on a typical passenger train architecture. Based on this study, a concept for an autonomous, GoA2 to GoA4 passenger train will be developed. Bombardier's «Virtual Bird» simulator will also be used to model the functional behaviour of the future autonomous passenger train. This groundbreaking project will bring advances in certain key functions and likely lead to new rail standards. Bombardier will draw on experience gained all over the globe to develop the autonomous train's on-board diagnostic system. This system will take steps to automatically repair a driverless train by making decisions and initiating corrective measures that will enable the train to resume service.

Next, Bombardier will play a significant role in the safety analyses required to authorise a first autonomous train to operate on the French and European rail networks. Bombardier will modify a Regio 2N trainset, designed and built at Crespin, by incorporating the various technological building blocks developed in the framework of this project. This first autonomous passenger train demonstrator will be able to operate without human intervention on tracks equipped with either ERTMS or lineside signalling.

## Our ambition

At a time when ecosystems are under pressure from increased mobility needs and the limitations of existing infrastructures, Bombardier is focusing its R&D efforts on providing transport operators with innovative, high-performance, and economical solutions. Bombardier Transportation is proud to ally its expertise as a rail integrator with the know-how of the other consortium members in the conversion project that will produce the first autonomous passenger train to run in France. It is an important project for the future that will benefit travellers and operators as well as give a boost to the rail industry.

## About Bombardier Transportation

Bombardier Transportation is a global leader in rail technologies. With the largest range of products and services in the industry, it offers the full spectrum of rail solutions, ranging from trains to sub-systems and signalling to complete turnkey transport systems, e-mobility technology, and data-driven maintenance services. As an innovative company, Bombardier Transportation continually breaks new ground in sustainable mobility by providing integrated solutions that create substantial benefits for operators, passengers, and the environment. Its products and services operate in over 60 countries. Headquartered in Berlin, Germany, Bombardier Transportation employs around 39,850 people.

France's number one industrial rail site, the Bombardier facility at Crespin, in northern France, employs nearly 2,000 people, including 500 engineers and managers. The company designs, builds, and commissions a large range of equipment and is specialized in double-deck platforms. Three major projects are now in production: the OMNEO (in the Premium and Regio 2N regional versions); the Francilien, an ultra-modern commuter train for Greater Paris; and the RER NG, produced in a consortium for the RER E and D Paris regional express lines.

BOSCH

## Our expertise

A leader in driver assistance and automated driving technologies for the automotive industry, Bosch applies its expertise to all types of mobility: automotive, rail, two-wheel, aviation, marine, and industrial and commercial vehicles, among others. Bosch has been developing solutions for the railway industry for many years and making every effort to become a leading supplier in this field. With its innovative collision warning system for light rails now in use in several large European cities, Bosch has demonstrated its capacity to apply automotive techniques in other mobility segments. Its collision warning system for light rails, which is paired with the driver assistance systems in the automotive sector, is being specially adapted and developed for railway customers.

## Our contribution to the consortium

Bosch is a leader in the field of automated driving. For many years, its extensive expertise in both physical and software technologies have made it an ideal partner for the autonomous train project. To enable these trains to detect signalling equipment and obstacles on the track in advance and react accordingly, Bosch offers two highly advanced environment recognition systems. The obstacle detection system detects obstacles present on the tracks. The signalling recognition system enables the train to detect all «Stop», «Track free», and «Passage of a train» signals. The two systems are based on proven Bosch sensor, video, and radar technologies and specially adapted for rail applications. The combination of these two systems with the systems and technologies of the other partners in the project will enable the train to run autonomously, without a driver. In short, these technologies serve as the train's «eyes».

## Our ambition

It is a great opportunity for Bosch to be able to develop automation technologies for trains with partners that are so complementary to one another. As a member of the consortium, Bosch will be able to demonstrate its expertise and deepen its know-how by applying automotive techniques to railway systems, while also continuing to develop its technologies for autonomous trains in line with the specific requirements of the railway sector.

## About Bosch

The Bosch Group has been present in France since 1899 and opened its first foreign production site in Paris in 1905. With 23 sites in France, eleven of which have Research and Development departments, all the Group's activities are represented in France. In 2017, Bosch France had about 7,500 employees and sales revenues of almost €3.2 billion in the country.

The Bosch Group is a leading global supplier of technology and services. It employs roughly 410,000 associates worldwide (as of December 31, 2018). The company generated sales of €78.5 billion in 2018. Its operations are divided into four business sectors: Mobility Solutions, Industrial Technology, Consumer Goods, and Energy and Building Technology. As a leading IoT company, Bosch offers innovative solutions for smart homes, smart cities, connected mobility, and connected manufacturing. It uses its expertise in sensor technology, software, and services, as well as its own IoT cloud, to offer its customers connected, cross-domain solutions from a single source. The Bosch Group's strategic objective is to deliver innovations for a connected life. Bosch improves quality of life worldwide with products and services that are innovative and spark enthusiasm. In short, Bosch creates technology that is "Invented for life."

The Bosch Group comprises Robert Bosch GmbH and about 440 subsidiaries and regional companies in almost 60 countries. Including sales and service partners, the Bosch Group is present in nearly every country in the world. This global engineering, manufacturing, and sales network is the basis for the company's future growth. Bosch employs some 64,500 associates in research and development at nearly 125 locations across the globe.

The company was set up in Stuttgart in 1886 by Robert Bosch (1861–1942) as "Workshop for Precision Mechanics and Electrical Engineering." The special ownership structure of Robert Bosch GmbH guarantees the entrepreneurial freedom of the Bosch Group, making it possible for the company to plan over the long term and to undertake significant upfront investments in the safeguarding of its future. Ninety-two percent of the share capital of Robert Bosch GmbH is held by Robert Bosch Stiftung GmbH, a charitable foundation. The majority of voting rights are held by Robert Bosch Industrietreuhand KG, an industrial trust. The entrepreneurial ownership functions are carried out by the trust. The remaining shares are held by the Bosch family and by Robert Bosch GmbH.

Additional information is available online at : www.bosch.fr, www.bosch-presse.de, www.twitter.com/BoschPresse and www.twitter.com/BoschFrance.

TECHNOLOGICAL RESEARCH INSTITUTE
RAILENIUM

## Our expertise

Railenium,the Technological Research Institute (IRT) of the rail industry, carries out innovation projects by creating partnerships with manufacturers and academics. It coordinates innovation projects addressing industry issues in cooperation with public authorities.

Railenium is focusing on three research and innovation programmes in the areas of infrastructure and rolling stock. The IRT's Autonomous Train programme will prepare the future of rail transport in France and globally by radically improving performance and quality of service.

The aim of Railenium's Autonomous Train programme is to bring about disruptive innovation and provide the tools and technological building blocks needed in SNCF's Tech4Rail programme and its autonomous train project.

## Our contribution to the consortium

The IRT is working with SNCF teams in a programme to operate automatic and then autonomous trains in a non-dedicated site. Several fundamental projects are being defined to achieve the following objectives: increase transport capacity, improve reliability, and reduce the costs of capital investment, operations, and maintenance.

In a systems approach to the operations of these autonomous trains, Railenium is integrating additional technological building blocks related notably to new signalling and control-command systems and to rail operations optimisation. The aim of this programme, which has been in progress since end-2016 in cooperation with the SNCF autonomous train project team, is to have freight and commuter train demonstrators ready by 2023.

## Our ambition

Railenium is pleased to be a driving force in France's rail sector and to contribute to the development and strengthening of R&D potential. The IRT wants to be a preferred partner of manufacturers and academics in their open innovation and collaborative programmes aimed at creating the rail transport of the future.

## About Railenium

The mission of Railenium, the Technological Research Institute (IRT) of the rail sector, is to develop the competitiveness of companies through collaborative innovation and make them drivers of growth and employment. Based in the Hauts-de-France region and supported by the State and the rail industry, the IRT partners with manufacturers and academics in innovation programmes to meet challenges in the rail industry through a network of centres of excellence and research laboratories.

SPIROPS
ARTIFICIAL INTELLIGENCE

## SpirOps: the art of capturing the nuances of human reasoning

The SpirOps approach is to capitalise on human experience and, with this objective in mind, to develop technologies to extract human reasoning and «transfer» it to a machine. This approach is particularly effective predicting and simulating human behaviour (like that of travellers on train platforms or in trains) or in performing a complex task ordinarily entrusted to people (e.g. driving a vehicle).

Today, SpirOps is partnering with several car manufacturers in the development of self-driving vehicles as well as with SNCF in research on the simulation of user behaviour.

## Our contribution to the consortium

In this project, SpirOps will have three objectives: first, to recommend to the driving module the appropriate actions to take in response to all kinds of unforeseen events; second, to «understand» behaviour on train platforms so that the doors are closed without danger to passengers before the train departs; and third, to rethink passenger information by taking a totally fresh look at the man-machine dialogue, with the aim of providing information and personalised services by communicating directly with the train's artificial intelligence.

## Our ambition

This project is a unique opportunity for SpirOps to advance its research, promote the industrialisation of its solutions, and above all, highlight a «soft» approach to artificial intelligence that is reassuring and that can be explained to everyone.

THALES

## Thales: the expertise of a major technology group devoted to the development of autonomous systems

In the «Passenger Service» consortium, Thales is the architect and systems integrator as well as the supplier of the ATO (Automatic Train Operation) module, which is the train's automatic pilot, and the localisation module, which is derived from those used in metros. Thales will also integrate the sub-systems supplied by the other members of the consortium.

An autonomous train operating in an open environment requires numerous modules and functional capabilities that are not necessary in a closed environment, like those in which metros operate.

Thales will therefore supply a new train positioning system that provides a high degree of integrity and is compatible with the operational security levels required for this type of use. The objective of the new positioning system is to eliminate the need for track equipment, thus enabling autonomous trains to run on any type of track. Beside the GNSS developed by our Avionics activity, this positioning system will use many diverse types of sensors (inertial units, LIDAR, RADAR, cameras, etc.).

With 30 years of experience in rail signalling systems and automatic metros, Thales capitalises on technologies and competencies available from other activities of the Group:

- The Avionics activity contributes to the train positioning system with GNSS satellite solutions already certified for secure applications according to aviation standards and with its know-how in sensor hybridization.

- The Secure Information and Communication Systems activity contributes to cybersecurity for the train and to the mapping system that is also part of the train positioning system.

We are allocating a substantial amount from our R&D budget (about 20% of Group revenues) to this major project, in which R&D centres in four countries will also be working. This is a typical Thales project, perfectly in line with the Group's strategy of contributing to the development of autonomous systems, whether for aeronautical, marine, terrestrial or spatial applications, relying on key digital technologies such as connectivity, Big Data, artificial intelligence and cybersecurity.

## About Thales

The people we all rely on to make the world go round – they rely on Thales. In a world that is increasingly fast moving, unpredictable – and full of opportunities, they come to us with big ambitions: to make life better, to keep us safer. Combining a unique diversity of expertise, talents and cultures, our architects design and deliver extraordinary, high-technology solutions. Solutions that make tomorrow possible today. From the bottom of the oceans to the depths of space and cyberspace, we help our customers think smarter and act faster - mastering ever greater complexity and every decisive moment along the way. With 65,000 employees in 56 countries, Thales had revenues of €125.8 billion in 2017.